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INTERRELATIONS OF STRESS AND ANXIETY
IN DETERMINING PROBLEM SOLVING PERFORMANCE

by

Clifford H. Block

Technical Report 8

DEPARTMENT OF PSYCHOLOGY AND
DEPARTMENT OF INDUSTRIAL ADMINISTRATION
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ABSTRACT

The experiment investigated problem-solving performance under three conditions of stress, with anxiety as an individual-difference variable. The first purpose of the study was empirical; the literature relating these variables to problem solving is inconclusive. The second purpose involved an assessment of the effects of discrimination between stresses on the basis of the extent to which they have ego-threatening properties.

In one high-stress condition, attempts were made to reduce ego-threatening cues and yet to induce anxiety; the threat of receiving painful electric shocks was used as the stress in this, the "Shock" condition. In contrast, an "Ego-threat" condition used instructions and procedures that emphasized the testing aspects of the experimental situation and attempted to associate performance on the problems with intelligence and with such concepts assumed to be related to ego integrity as masculinity, individualism, and good mental health. Both stress situations were compared to a Control condition, which was designed to be low on both ego-threatening cues and other stress cues.

Individual differences in anxiety were indexed both by the Test Anxiety Questionnaire (TAQ) (as well as several other questionnaire measures of the predisposition to anxiety) and by two indices given at various times throughout the testing session, one an adjective check list measure (ACL) and the other a measure of palmar perspiration (PPM). In addition, an attempt was made to index changes in Drive level by using two forms of a paired-associates learning task thought to be subject to facilitation by stress and anxiety.

Use of the ACL as an index of how effective the stress manipulations were in affecting anxiety arousal indicated that the Shock and Control manipulations functioned as intended but that the Ego-threat manipulation did not produce the intended anxiety increase; the Ego condition was therefore dropped from subsequent analyses. Since neither the PPM nor the learning task yielded the anticipated results, the ACL was used as the primary arousal index.

Performance on a series of 12 reasoning problems was found to be related to TAQ level. In the Control condition, the middle TAQ group was inferior to the two extreme groups; in the Shock condition, the low TAQ group was superior to the groups at higher TAQ levels. In addition, there was a significant stress effect, with the Shock condition producing superior performance; however, this held true only for subjects of high intellectual aptitude.

The evidence suggested, although not conclusively, that the problem solving differences related to stress and to TAQ were not a function of differences in anxiety arousal, at least as measured by the ACL. The results were, therefore, interpreted by assuming that both TAQ and aptitude are related to differences in the level of self-confidence, and that the latter mediated the facilitative stress effects that were observed. The discussion also emphasized, first, the importance of having measures of aroused anxiety when interpreting stress and predispositional-anxiety effects and, second, the possible insensitivity of problem solving to some debilitating anxiety effects.

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This study was undertaken in an attempt to determine how certain dimensions of anxiety and stress relate to effectiveness in problem solving. While the literature relating anxiety variables to performance is voluminous, the vast bulk of it is concerned exclusively with performance on rote learning tasks. Where the performance is achievement in problem solving, there is a paucity of evidence. The first purpose of this study, then, was simply empirical--to extend, to some degree, the available information on the relations of anxiety and stress to problem solving.

In addition, this study was intended as a test of certain hypotheses relating to the mechanisms of stress and anxiety. This was necessary, because even a fundamentally empirical investigation, when it is concerned with anxiety-related concepts, must become deeply involved with theoretical systems. The complexity of these concepts has given rise to a rich variety of theoretical interpretation which the available data have done little to clarify. The assumptions that were made about the mechanisms of anxiety were critical in determining the nature of the present investigation. Hence, the theoretical model that underlies the manipulations and measurements used here will first be briefly outlined.

Theoretical Model of Anxiety

There were three assumptions basic to the present working model of anxiety. The first was that the most important factor determining whether stress will facilitate or will debilitate performance (in problem solving, at least) is the presence or absence of a feeling of threat to

one's ego-integrity. When responses related to ego-threat are predom-
inant, stress will disrupt performance. When they are not predominant,
stress will be facilitative.

The responses mediated by such feelings of ego-threat might include
thinking self-accusatory thoughts, fixating on the threatened punishment,
and such ego-defensive responses as escape through fantasy, a lowering
of attention to the threatening task, depression of arousal level, and
perseveration. All of these would preclude constructive, task-oriented
activity[1].

When these ego-threat related responses are not dominant, we assumed
that the responses to stress will consist of such ordinarily facilitative
responses as increased task attention and a higher task-oriented energy
level[2].

The second assumption was that two factors are of prime importance
in determining whether a feeling of ego threat will be present: first,
the cues of the stress situation itself, and, second, the strength of
individual responsiveness to such cues.

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1. It is true, of course, that the tendency for an ego-defensive response
   to be disruptive of performance will vary with the task. Ruebush (1960),
   for example, has demonstrated that high-anxious subjects tend to be
   more cautious and that, for a task like the Witkin Embedded Figures
   Test, cautiousness leads to superior performance. Similarly, Waite
   (1959) predicted correctly, on the basis of task characteristics,
   facilitation for anxiety on the Stroop Test and debilitation on the
   Porteus Maze. The assumption in the present study was that ego-
   defensive responses would tend to be disruptive for the kind of
   problem solving task used here.
2. The distinction being made here perhaps relates to the distinction made
   by Freud between "neurotic anxiety" and "objective anxiety" or fear.
   In objective anxiety, one's energies are directed toward dealing with
   the external threatening object. In neurotic anxiety, the emotional
   reaction is inappropriate to dealing with the threatening object.

The third assumption was that the degree of effect of the stress, either facilitative or debilitative, will vary as a multiplicative function of the intensity of anxiety that is aroused. This assumption is fundamentally that whatever responses are cued off by stress will be energized, in the Hullian Drive-multiplicative fashion, by the degree of anxiety-associated activation that is aroused.

Finally, it is important to note an assumption that response to one of the standard scales of test-related trait anxiety, the Mandler-Sarason Test Anxiety Questionnaire (TAQ), reflects individual differences both in the tendency for a stress to be interpreted as ego-threatening and in the typical level of stress-associated anxiety arousal[3]. The rationale for this assumption is in part based on the character of the items of the TAQ. Some of the items refer to the subjective content of cognition and mood when in a testing situation, e.g., confidence, worry, etc.; others refer to symptoms of arousal, such as accelerated heartbeat. The former, it was hypothesized, reflect largely (although not exclusively) ego-threat sensitivity, the latter largely anxiety arousal[4].

This study was designed to test some of the implications of this

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3. Further discussion of the TAQ can be found in the section on Design and Procedure.
4. The model that is here proposed involves many constructs derived from the theoretical work of Child (1954) and Alpert and Haber (1960), and particularly of those who have developed and worked with the Test Anxiety Questionnaire (e.g., Sarason and Mandler, 1952; Mandler and Sarason, 1952; Ruebush, 1960; I. Sarason, 1956a, 1956b, 1957, 1958, 1960, 1961). Each of the first two assumptions is related to concepts developed by these theorists. The third assumption, on the other hand, is more closely akin to the thinking of the Drive theorists, such as Spence and J. Taylor (e.g., J. Taylor, 1953, 1956; Spence and Farber, 1953; Spence, Farber, and McFann, 1956; Spence, Farber, and Taylor, E., 1954; Spence, Taylor, and Ketchel, 1956; Farber and Spence, 1953; Taylor and Spence, 1952).

model by contrasting the effects of two stress situations, one designed to have many ego-threatening cues, the other to have few such cues, yet still to be stressful. Problem solving performance under each of these types of stress was compared with performance in a control situation that was low in stress cues of any sort.

Anxiety was measured first as a trait, or predisposition, by the TAQ and other anxiety questionnaires. Then, at the time performance measures were taken under the different stress conditions, anxiety was measured in terms of variations in its intensity as a transient state. Such measures were needed, of course, to evaluate the assumptions concerning the energizing effects of aroused anxiety. But they were also considered to be of great importance in assessing how effective the stress manipulations were in actually producing anxiety. It is rather surprising that such measures of the effectiveness of the manipulations have rarely been utilized; their use might well have clarified a number of the apparent contradictions in the literature[5]. A final virtue of the use of such measures is that they make possible the testing for differences, if any, between the effects of anxiety as a personality trait and anxiety as a transient state.

Evaluation of the Literature

The relevant experimental literature falls into two categories. The

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5. It should be noted that measures of aroused anxiety taken just prior to and during the observation of performance differ radically from the more frequently utilized "take" measures given at the conclusion of the experiment. Such post-experimental take measures are very sensitive to distortion by the quality of the subject's performance on the criterion task.

first concerns the evidence bearing upon a suggested distinction between stresses high and low on ego-threatening cue value; this evidence comes entirely from the literature on learning. The second category is comprised of those studies of anxiety and stress that have investigated problem solving, per se. Each of these categories will be examined in turn.

The suggestion here being proposed is that a distinction should be made between stresses on the basis of their ego-threatening cue values; this distinction was arrived at in an attempt to clarify to some degree the very contradictory literature on anxiety effects. Although there have been no investigations aimed explicitly at making this discrimination, there are suggestions of the validity of such a distinction in the literature where learning is the criterion task. In support of the ego-threat distinction, there are first the results of the most common experimental design, that comparing an ego-threatening stress with a low-threat control condition. The most frequently found result is that there is disruption, for those subjects who score high on anxiety as a trait, under the ego-threat condition. (For example, see J. A. Taylor's summary, 1956, and also Nicholson, 1958; Lucas, 1952; and Katchmar, 1958.)

The next question, then, is whether there is any evidence that a stressful situation which is low in ego-threatening value will have a different effect on the performance of anxious subjects than the disruption commonly noted for ego-threatening stresses. A stress that implies shock or threat of shock as the stress agent would appear to potentially meet this qualification, provided other sources of ego-threat were low. There are three such studies which may be cited, all providing

some support for the view. Chiles (1958) found that random shocks
facilitated the learning of paired associates lists, even when the
lists were high in response-competition characteristics. Further,
subjects high on trait anxiety were more facilitated than those who
were low anxious. Deese, Lazarus, and Keenan (1953), who used both
avoidable and non-avoidable shock, also found facilitation for high
anxious subjects (although only in the avoidance condition), this
time in a serial learning task; here, low anxious subjects were ac-
tually hurt by the stress (in both the avoidance and non-avoidance
conditions). Finally, a shock-threat study by Silverman and Blitz
(1956) also had serial learning as a criterion and used avoidable
and non-avoidable shock threat. This study demonstrated little
effect on high anxious subjects, but low anxious subjects showed
facilitation in the avoidable condition and debilitation in the non-
avoidable condition.

While these studies show certain contradictions in detail, they
are consistent in showing that shock as a stressor can facilitate
performance; two of the studies suggest that this holds true even
for high anxious subjects. In none of the studies did shock stress
disrupt the performance of high anxious subjects; this result stands
in marked contrast to the findings that have used stresses high in
ego-threat. The evidence thus appears sufficient to warrant further
investigation of the proposed distinction among stresses based on
differences in ego-threat value.

In turning now to an examination of anxiety studies in which
logical problem solving was used as the criterion task, we find that

there is little evidence directly relevant to the purposes of this study. In no studies that we have encountered has a stressful situation been produced which would be judged as low on the ego-threat dimension. And in only two studies have the stress and trait anxiety variables been simultaneously investigated.

These problem solving studies can be grouped into three categories: (a) those which have examined only the effects of stress on problem solving; (b) those which have examined only the relation of predisposition-to-anxiety to problem solving; and (c) those which have examined the relationship of both stress and predisposition-to-anxiety to problem solving.

In the first category, examining only the effects of stress, Truax and Martin (1957) failed to find any effects of the degree of ego-threat on performance on the Arithmetic subscale of the Wechsler-Bellevue. Similarly, Reynolds (1960) found that an ego-threat manipulation had no effect on achievement on Thurstone's Space Problem. On the other hand, Beier (1951), using a severe unavoidable ego-destructive stress, found that threat disrupted performance on a complex reasoning task and on the Abstract Reasoning subtest of the Differential Aptitude Tests. Similarly, Rhine (1955) found that the solving of anagrams was disrupted by failure experiences. Finally, Ray (1960) found that the number of errors made on a disc-transfer problem, the "Tower of Hanoi" puzzle, was greater for subjects operating under time-pressure stress than for those who were not. However, the time taken for solution did not vary with the stress condition.

In the second category, examining the relation between performance and predisposition-to-anxiety, several studies have been done, with as

contradictory results as those for stress. Three studies suggest a positive relationship with trait anxiety. Ruebush (1960) found that anxiety was related positively with performance on the Witkin Embedded Figures Test[6]. However, this was true only for low and middle I.Q. subjects; for high I.Q. subjects (I.Q. range of 111-122), there was a not quite significant trend in the opposite direction. High quality performance on this task, however, is dependent on cautiousness, which Ruebush demonstrated to be a correlate of high anxiety. Similarly, Maltzman, Fox, and Morrisett (1953) found that high-anxious subjects were superior to low-anxious subjects on an anagrams task. Finally, Van Buskirk (1961) demonstrated an advantage for high-anxious subjects on a task of logical deduction. There are two interesting notes about his experiment. First, the ego-threat value of his situation was probably fairly low. In addition to being paid, his subjects were offered cash prizes for superior performance, thereby perhaps making it more game-like than the usual testing situation. Second, although trait anxiety was positively correlated with performance, a separate fear-of-failure scale was negatively correlated.

In direct contrast to the facilitation by anxiety reported in the three studies above is the report by Wiggins (1957) of a negative correlation of -.82 between number of solutions on a multiple-answer anagrams test and manifest anxiety, when intelligence (which correlated +.82 with anagram performance) is partialled out. In similar contrast to the above

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6. The Concealed Figures Test (Thurstone and Jeffrey, 1956), a very similar test, was demonstrated by Berry (1959) to correlate .60 with a problem solving scale similar to that used in this experiment.

findings are the reports of many investigators (e.g., Calvin, Koons, Bingham, and Fink, 1955; Grice, 1955; Kerrick, 1955; Sarason and Mandler, 1952; Waite, Sarason, Lighthall, and Davidson, 1958) of negative correlations between the Taylor Manifest Anxiety Scale or the Test Anxiety Questionnaire and intelligence test scores. They used such scales as the Wechsler-Bellevue, the Henmon-Nelson, and the Air Force Qualification Test. The range of most of the correlations is from -.20 to -.40. They tend, however, to be highest for subjects in the lower part of the I.Q. range.

To add to the confusion regarding the relationship of trait anxiety to problem solving performance, it is to be noted that manifest anxiety was found to be unrelated to performance both on Maier's two-string problem, in a study by Staats (1957), and on the "two-spheres" problem, in a study by Maltzman, Eisman, and Brooks.

The studies of greatest relevance to the present study are those in the third category, which simultaneously varied both stress and predisposition-to-anxiety for a problem solving task. The two studies with content at all similar to the logical problem solving used in the present experiment yielded ambiguous conclusions. Graff (1957) used reports of success or failure as stressors on an anagrams series; he also measured trait anxiety. He found that failure stress improved the performance of high anxious subjects, while approval debilitated performance. For low anxious subjects, a tendency in the opposite direction was found. Travers, Marron, and Post (1955) investigated the performance of Air Force cadets on a complex administrative problem having a unique solution. The independent variables were both the predisposition to anxiety, as measured

by three levels of the Taylor Manifest Anxiety Scale (1953), and stress,
manipulated by varying the degree of ego-threat. In two replications,
identical except that they were conducted at different Air Force bases,
threat had opposite effects--facilitating in one experiment, debili-
tating in the other. Moreover, both the interaction of stress and anxi-
ety, and the anxiety effect (which tended to be curvilinear) were differ-
ent in the two replications. The authors suggested that there might
have been some difference in the composition of the population at the
two air bases, but there is no evidence of what this difference might
have been.

Taken overall, these studies present a confusing picture. The dif-
ferences among them on task characteristics, stress manipulations and
subject populations make the process of generalization well nigh impos-
sible. The need for further investigation seems apparent.

Purposes and Hypotheses

As was stated earlier, the purposes of this study were two: first,
it was an empirical investigation of stress and anxiety effects on logical
problem solving, an area in which, as we have just seen, there are little
consistent data; and second, it was an attempt to test a set of assump-
tions about the mechanisms of anxiety and stress in affecting problem
solving performance.

One of the assumptions of the model suggests that the ego-threat
characteristics of the stress situation are critical in determining
whether the responses to stress will be facilitative or debilitative.
The present experiment examined the effect of this variable by comparing

problem solving performance under three conditions, as follows: a shock-
threat condition, designed to be stressful but low on ego-threat; an
ego-threat condition; and, a control condition low on all stress cues.

Another assumption is that subjects vary both in the degree to
which they respond with anxiety to stress situations and in the extent
to which responses associated with ego threat are produced by stress. In
examining these individual differences, the TAQ was the major instrument,
although other scales indexing predisposition-to-anxiety were included.

Finally, another important assumption was that the level of aroused
anxiety energizes either facilitative or debilitative tendencies. In
order to directly measure the level of aroused anxiety, both a physiolog-
ical and a mood self-report measure of aroused anxiety were given fre-
quently throughout the testing session. In addition, an attempt was made
to infer the extent of Drive level changes from changes in performance
on a learning task.

The implications of this model led to certain expectations for the
results. First, it was expected that Shock stress would tend to facili-
tate problem solving performance, in comparison with performance under
low stress, Control, conditions. The assumption was of course that the
relative lack of ego-threatening cues in this stress condition would per-
mit facilitative responses to be dominant. To the extent that they were
energized by stress-produced anxiety, these responses would facilitate
performance.

On the other hand, Ego stress would tend to debilitate problem solv-
ing performance, in comparison with performance under low stress, Control,
conditions. The basis for this prediction was the expectation that the

Ego stress condition would be high in ego-threat cue value, and would therefore tend to produce responses related to the defense of ego-integrity. Such responses, because of their irrelevance to the task, were assumed to be debilitative. The anxiety that was aroused would therefore energize task-disruptive responses.

While we have thus far been discussing the probable main effects of stress, it was also expected that anxiety level, as indexed by the TAQ, would interact with the stress effects. We will first consider only the assumption that the extent of facilitation or debilitation will be determined by the degree of aroused anxiety, in a Drive-multiplicative fashion, and that TAQ level reflects, in part, the probable level of anxiety aroused by stress. It can then be predicted that the level of trait anxiety, as measured by TAQ, will be negatively related to problem solving performance when stress is disruptive, as in the Ego condition, and positively related when stress is facilitative, as in the Shock condition.

It should be noted that this prediction does not take into account the assumption, previously discussed, that TAQ level also reflects the degree of sensitivity to ego-threatening cues. When this assumption is taken into account, the prediction relating TAQ level to performance under Shock stress must be qualified. It might be expected that some chronically high-anxious subjects would have such a strong tendency to react with ego-threat-related responses to any testing situation that they would be debilitated even by the conditions of the Shock stress. If so, we would expect some High TAQ subjects to be highly facilitated and others to be highly debilitated by Shock. If this were true, instead

of high overall facilitation for High TAQ subjects, a high degree of var-
iance would be expected in the Shock condition among subjects high on
TAQ level.

A similar qualification may hold for the performance of low TAQ sub-
jects operating under Ego threat. It is probable, perhaps, that many sub-
jects low on trait anxiety are so insensitive to ego-threatening cues that
they would be facilitated by stress even in the Ego stress condition. Since
the degree of energizing anxiety would not be high. in these subjects, the
degree of facilitation would be expected to be only moderate in degree.

It should be noted that these two qualifications, which are depend-
ent on the assumption of differential sensitivity to stress cues of low
and high trait-anxious subjects, lead to predictions of curvilinear re-
lationships. In the Ego condition, the curvilinearity would not be so
marked, since the suggestion is merely that instead of being slightly
debilitated, this group will be slightly facilitated. But in the Shock
condition a situation could arise where a group in the middle on TAQ level
would be superior to both of the other groups--superior to the low TAQ
group because of its higher arousal level, superior to the high TAQ group
because it does not have dominant disruptive tendencies [7].

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7. Independent of the formal model that has been proposed, another
   variable was suggested as perhaps being important in determining
   the mode of response to stress. This variable is confidence level.
   It was suggested that facilitative responses to stress would be
   more likely to occur among confident subjects. While the present
   experiment was not designed to directly evaluate this hypothesis,
   it was noted at the outset that the confidence variable might
   manifest itself in differences in the behavior of subjects of
   different aptitude levels. Assuming that those subjects who were
   higher in aptitude were more confident, perhaps because of a higher
   frequency of reinforcements in academic testing situations, it was
   anticipated that there would be greater facilitation and less debili-
   tation among high-aptitude subjects than among low-aptitude subjects.

One final expectation should be noted. As indicated above, direct measures of anxiety arousal were obtained in the experimental situation. From what has been said before concerning the role of aroused anxiety in energizing responses to stress, it follows that these direct measures should be related to differences in performance in the various stress and anxiety subgroups. The role of aroused anxiety in mediating stress and trait anxiety effects is also of interest apart from its relation to the particular model described here. It seems a question of fundamental importance both empirically and because of its implications for the several theories of anxiety that are currently prominent. The currently available evidence directly bearing upon this question is very slight.

DESIGN AND PROCEDURES

Subjects

The subjects were Airmen enrolled in an intensive course in Chinese taught at Yale University.

Design

The experiment was conducted in two sessions, the first designed to gather data relevant to individual differences in predispositions to anxiety. One of the predispositional anxiety scales was then used in assigning subjects to the second session, in which problem solving performance was observed under a variety of stress conditions.

In the first session, a set of six paper-and-pencil anxiety scales was administered to 242 subjects, in large groups.

Of the subjects so tested, 180 were recruited to act as paid partici-
pants in the second session[8, 9]. Although in this latter session subjects were tested in groups of four or five at a time, an attempt was made to approximate an individual-testing atmosphere. Each individual was seated in a booth from which the only other individual visible was the experimenter; talking among subjects was prohibited.

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8. The proportion of subjects who volunteered for the second session was actually much higher than the 75% rate indicated, since several entire units graduated before they could be used. More than 90% of those asked to participate did so, and approximately half of the refusals came as a result of unavoidable scheduling difficulties. There was therefore little opportunity for the distortion of results by self-selection.
9. Subsequent attrition resulting from incomplete data caused the number of subjects whose results were usable to be reduced to 167.

During this session, all subjects were tested on the same series of questionnaire and performance measures. However, the conditions of testing were experimentally varied in an attempt to produce three different stress conditions: low stress, ego-threat, and shock-threat. One third of the subjects were assigned to each stress condition.

The sixty subjects within each stress condition were divided on the basis of their scores on one of the scales administered during the preceding session, the Mandler-Sarason Test Anxiety Questionnaire (TAQ). In each stress condition one-third of the subjects was taken from the lowest third of the TAQ distribution, another from the middle third, and another from the highest third.

A summary of the experimental procedure in the second session is presented in Table 1. All subjects were initially administered several scales, before the stress instructions were introduced. These were as follows: two measures of currently-aroused anxiety, including one questionnaire measure (Adjective Check List, or ACL) and one physiological measure (the Palmar Perspiration Measure, or PPM); one form of an "Attitude toward Problem Solving" scale; and one form of a paired-associates learning task that was designed to indicate Drive level. Then, the stress manipulations were introduced through instructions concerning the tasks to follow. Next, another set of anxiety and attitude measures was taken, a second paired-associates learning task was administered, and the primary criterion task, problem-solving, was administered. After half the problems were completed, a third PPM measure was taken. Finally, at the conclusion of the problems, just before the subjects were made aware that there would be no more problems, final anxiety measures were taken and

Table 1

Order of Experimental Procedures

1. Seating, general introduction, etc.

2. Initial instructions and Palmar Perspiration Measure #1.

3. Adjective Check List #1.

4. Attitude A.

5. Learning Task Instructions.

6. Learning Task A.

7. Stress instructions.

8. Palmar Perspiration Measure #2.

9. Adjective Check List #2.

10. Attitude B.

11. Learning Task B, with instructions.

12. Six successive items of Problem Solving Task.

13. Palmar Perspiration Measure #3.

14. Six successive items of Problem Solving Task.

15. Palmar Perspiration Measure #4.

16. Adjective Check List #3.

17. Post-experimental "Take" Questionnaire.

18. Final instructions.

a questionnaire relating to feelings aroused during the experiment was given. A discussion to explain the deceptions involved in the stress manipulations completed the session. The total time required was approximately two and one-half hours.

Scales[10]

Anxiety Predisposition Scales Administered During Preliminary Session

A number of different anxiety questionnaires were administered during the preliminary session, each measuring a somewhat different aspect of the concept of anxiety. One of these scales, the Mandler-Sarason Test Anxiety Questionnaire (1952), was the scale of central interest. The other five scales were presented partly because of the convenience of collecting the additional data at the same time. Since the other scales were designed primarily to serve an exploratory function in investigating the relationships among certain components of anxiety, a function peripheral to the main focus of the experiment, the description of the scales and the results obtained will not be included here. The interested reader may find this information in Block (1963, Appendices B, D, and E).

Mandler-Sarason Test Anxiety Questionnaire ("TAQ"). This is a version of the scale developed by Sarason and Mandler (1952) and used in a number of subsequent studies. This scale deals with self-reports of manifest

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10. Copies of all scales used in the experiment are reproduced in Block (1963, Appendix B.)

anxiety symptoms that have been experienced immediately before and during testing in the classroom and in intelligence test situations. For this experiment, the usual 35-item scale was reduced to 31 items by omitting four items that referred specifically to the disruption of performance during testing situations. All other items referred to more general indices of anxiety arousal during testing situations, such as perspiration, accelerated heartbeat, the lack of feelings of confidence, and feelings of worry or uneasiness[11].

Intellectual Aptitude Scales

Armed Forces Qualification Test. This test had been taken by all subjects upon entering the Air Force. It provides percentile scores on four aptitude factors: Mechanical, Administrative, General, and Electronics. It should be noted that the labels are somewhat misleading. It was reported, for example, that the subjects' ability to learn Chinese correlated best with Electronics aptitude[12].

The range was somewhat restricted on all but the Mechanical ability factor, since scores on the other three aptitude factors had been used as criteria in selecting these men for participation in the Chinese course.

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11. The items that referred specifically to disruption were omitted in order to clarify the interpretation of any correlation that might be obtained with problem solving performance in this experiment. The aim was to eliminate the possible interpretation that the correlation simply represented a continuity between the subject's past performance under stress (as reported by him on those items of the TAQ) and his performance under the stresses of this testing situation. That is, the aim was to modify the TAQ to make of it a scale concerned only with the arousal of anxiety-associated feelings, apart from any effect of these feelings on the quality of test performance.
12. This report was in the form of a personal communication from Mr. Robert Tharp, an administrator of the Institute of Far Eastern Languages, at which the subjects were enrolled.

Scales Administered During the Stress Session

Palmar Perspiration Measure ("PPM"). The PPM is a physiological
measure assessing the amount of sweat produced on the finger-tips during
a given period (in this experiment three minutes). The rationale for
the use of this measure (hereafter referred to as the PPM) is that it is
an index of autonomic nervous activity and thus of at least a major com-
ponent of anxiety. Mowrer (1953) and Bixenstine (1955) have each reported
correlations between PPM and the degree of stress probably present during
the course of psychotherapeutic sessions and in long-term life situations.
There is little evidence relevant to the question of how it reflects re-
sponses to more transient stresses; however, Beam (1955) and Paivio and
Lambert (1959) provide evidence suggesting its usefulness in this regard,
and pretesting indicated that the measure was likely to be a useful in-
dicator for present purposes.

The procedure for obtaining this index is described in Block (1963,
Appendix F).

Mood Adjective Check List (ACL). This is a check list consisting of
61 self-descriptive adjectives describing present mood. Subjects are asked
to respond to each item on a four-point scale, according to the extent to
which they are at that moment experiencing the feeling described by the
adjective.

The instrument used in this study was produced by combining a 40-
item list published by Nowlis (1960) with two anxiety-related adjectives
found in previous Nowlis studies and with a 19-item list used by Zucker-
man (1960). In the 61-item list thus created, there is a 16-item cluster
of adjectives that have been shown either by Nowlis or by Zuckerman to be
positively related to anxiety; they include such adjectives as "afraid,"

"ashamed," "helpless," "apprehensive," and "upset." The analyses to be reported in this paper center exclusively on this anxiety cluster. The other adjectives were included both to mask the emphasis on anxiety and to provide additional data, if desired, regarding mood changes caused by the experimental manipulations.

Other Scales. Two other scales were administered during the stress sessions. Since the results of neither is central to the investigation, they will merely be mentioned here. The first is a set of parallel 16-item scales of attitude toward problem solving included to assess stress effects on attitudes related to performance. A further description of this measure and its relationships with other variables is included in Block (1963, Appendices D and E).

The other scale was a post-experimental "take" questionnaire, which included 19 Likert-type items. Four additional items were included for the subjects in the Shock condition. Since the results obtained on this scale paralleled those obtained for the ACL, and were methodologically less adequate because of their post-facto nature, they are not included in the report.

Performance Measures

Paired-Associates Learning Tasks. Spence, Farber, and McFann (1956) have reported a study of the effect of anxiety on the learning of a paired-associates list having special characteristics. The list was designed to have little response competition among different pairs and high associative strength between the members of the pairs. The authors found, as predicted by the Spence-Taylor Drive Theory of manifest anxiety, that high anxious subjects learned the list faster and made fewer errors than did low-anxious subjects.

The intent in the present experiment was to use performance on a similar list as another measure of the level of activation induced by the experimental conditions. If the stresses increase Drive level, learning should be more efficient when the subjects are under stress than when they are not. The relative change in performance from low stress to stress condition might, it was thought, even be usable as an individual difference "tracer" of the amount of Drive increment induced in each subject by the stress instructions.

Therefore, two lists, each consisting of fifteen pairs of two-syllable, synonymous adjectives, were constructed. List A was presented to all subjects before the differential stress instructions were given and List B was presented immediately after the stress instructions. (The order of presentation of the lists was not counterbalanced because of the wish to use individual scores in correlations.) Eight trials were given, with the order of the pairs randomized from trial to trial. Measures used were (a) total number of errors, and (b) number of trials required to reach a criterion of two successive errorless trials.

A procedure was developed for collecting the data in a testing situation where five subjects served simultaneously. The details of administration, as well as the criteria used in developing the lists, are available in Block (1963, Appendix G).

Problem Solving Task

The index of problem-solving performance was a set of 12 logical problems. The problems were selected so as to be primarily verbal-logical in character and to have comparatively low loadings on the following factors which frequently appear in problem solving sets: spatial or mechanical

ability, mathematical ability and mathematical experience, and memory. The goal was to have a set of problems in which, as much as possible, the information, experience, and specific abilities required for solution were available to every subject. It was hoped that performance on such a set of criterion problems would primarily reflect the effect of motivational dynamics on the heuristic or algorithmic processes involved in solving the problems, rather than reflecting learning or remembering functions.

Ten of the twelve problems that were used were selected from among those used in studies by Sweeney (1952), Nakamura (1955), Milton (1957), Carey (1958) and Berry (1959). Eight of the ten had been parts of problem sets which had been shown by the above authors to reflect such personality or motivational characteristics as conformity, masculinity-femininity, attitude, and field-dependence. In addition to these ten problems, two were selected from puzzle books.

Each problem had a single correct solution. Ten of the twelve problems were scored 1 for a correct solution and 0 for an incorrect solution; for the other two (A-1 and B-5), scores of 1/2 were given if the correct solution was obtained but the explanation was incomplete.

The problems represented a wide range of difficulty; performance on pretests ranged from 93% solution for one problem to less than 4% solution for another.

Pretests indicated that the problem set was responsive to anxiety and stress differences [13]. Of four independent comparisons of stress condition means with control means, with a small number of subjects (eight to ten)

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13. A summary of the results of the two pilot studies using this scale as the criterion task can be found in Block (1963, Appendix A).

per cell, one comparison reached the .05 significance level, another approached the .05 level, and a third was between the .10 and .20 level.

Each problem was individually timed, with two and one-half minutes allowed per problem. Problems were given in two six-problem booklets, a separate problem per sheet. The sheet containing the problem just completed was torn off at the end of the two and one-half minute period. Six problems were presented successively, there was then an intermission (of approximately four minutes) during which a palmar sweat measure was taken, and then another six problems were successively presented. The subjects at no time had any way of knowing how many problems there would be in all.

Stress Manipulations[14]

Low Stress Condition

An effort was made to minimize the ego-involving stress conditions that are usually present in a testing situation. The intent was to eliminate the following expectations that are usually produced by a testing situation: that the quality of the subject's performance will be made known to the subject himself, to his peers, or to important authorities; that his individual score will be judged in relation to some standard of achievement; that the tests are related either to intelligence or significant personality traits; and, that the quality of per-

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14. The instructions used are included in Block (1963, Appendix C).

formance will be partly dependent on remembering things that had previously been learned. Additional techniques aimed at reducing ego-threat included calling the problems "puzzles" instead of "problems," picking up the completed problems without looking at them, and placing the collected problems in a conspicuous place, where it was obvious they were not being graded.

As incentive, it was noted that each individual's performance would reflect how well his group did in relation to other Air Force units and would also determine the success of the experiment. Subjects were urged to work as intensely as possible and to keep trying throughout the entire course of the experiment.

Shock Stress Condition

Subjects in this condition received the same ego-threat reducing instructions as those in the Low Stress condition. However, the threat of avoidable pain was added. Subjects were told that the level of their performance would determine how many shocks they would later receive and how painful they would be. They were told that with maximum effort they could avoid receiving any shock; effort, rather than intellectual capability, was stressed.

In order to reduce the ego-threat component introduced by the necessary scoring of the problems during the session, a hypothetical associate was introduced. Papers were collected with the experimenter not looking at them and were taken down the hall. There they supposedly were to be graded by the hypothetical associate, who would then later conduct that phase of the session involving the administration of shock. The subjects were told explicitly that the experimenter himself would not know how

well they were doing. Since the subjects did not know how many problems were involved in the total task, they probably did not know even near the end that the experiment had been virtually completed without their having been shocked; the implication even at the end of the problems was that there were additional problems yet to come.

The apparatus used to deliver the shocks, a Harvard inductorium equipped with a five-position switch, was kept covered until the stress instructions were begun. At the conclusion of these instructions, each subject attached electrodes to his ankle. Supposedly as a test of the connections, a shock was administered to each subject in turn. The subjects were told that this would be a comparatively mild shock; actually, the apparatus was set to deliver a rather intense, painful shock, although a very brief one.

Although no further shocks were actually delivered, the apparatus, which produced a rather fearsome sound, was repeatedly turned on during the testing, with the experimenter appearing to try to get it into adjustment. It was on approximately one-third of the total time; it was turned on and off four to six times during the session and was left on about three minutes each time.

Ego Stress Condition

The ordinary conditions of testing provide perhaps the most important cues for evoking a sense of avoidable threat to the self-image; to some extent, the instructions and conditions were aimed merely at emphasizing these cues (while the instructions for the other two groups were directed toward de-emphasizing them). The problems were labelled "tests" and "problems" instead of, as with the other groups, "puzzles." The scores

of each subject were to be publicly announced, relative both to the other
subjects and to broader standards, at the end of the session. The exper-
imenter collected each problem immediately after it was finished, looked
at the subject's answer while standing in front of the subject, and then
ostentatiously engaged himself in scoring the problems.

In addition to this emphasis on ordinary testing cues, an attempt was
made to induce the belief that by good performance in relation to his own
ability the subject could ward off the ego-threatening possibility of be-
ing labelled (either by himself, his peers, or authorities) as either
emotionally disturbed or not intelligent. This was done by telling the
subjects that the focus of the experiment was on emotional disturbances
that interfere with clear thinking, and that performance on the tests was
sensitive not only to intelligence, but also to such personality factors as
masculinity-femininity, conformity, ability to relate to people, rigidity
of personality, and emotional control. They were told that those subjects
who did more poorly than their abilities warranted would be called in for
further testing, of a clinical nature, to try to determine the root of the
trouble. It was implied that the language school authorities would know
who was being called in.

Final Instructions

At the end of the session, the deception was explained to the Ego
and Shock groups, with apologies and explanations of the necessity for
such deception. To all subjects, a serious plea was made for secrecy,
and the subjects were paid. Inquiries directed to each subject before
he began the experiment strongly indicated that security was maintained
throughout the course of the data collection.

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RESULTS

In presenting the results, the success of the stress manipulations
will first be examined. There will follow an assessment of the relation-
ship of the problem solving scores to both stress condition and TAQ level.
Finally, an analysis will be undertaken to ascertain the extent to which
the observed stress and TAQ relationships with problem solving relate to
the level of anxiety arousal extant during the testing situation.

Effectiveness of Stress Manipulations

Before examining the effects of the stress manipulations on problem
solving, it is necessary to determine the effectiveness of the manipula-
tions in creating anxiety. This study includes two direct measures of
anxiety arousal, the ACL and the PPM, and one indirect measure, perform-
ance on the learning task.

Table 1 presents the scores on the ACL measures. The Control (low
stress) group declined slightly in self-reported anxiety after hearing
the stress-reducing instructions; by the end of the experiment the decline
reached a statistically significant level ($t=2.95$, $p=.01$). The Ego Stress
group unexpectedly remained at essentially the same level throughout the
experiment. The Shock Stress subjects felt significantly more anxious
immediately after receiving the stress-inducing instructions ($t=2.63$,
$p=.02$) and remained at the higher level.

These conclusions are amplified by an analysis of covariance of the
second ACL with the first ACL used as the control measure. This analysis
was executed on a 3X3 matrix, consisting of three levels of TAQ by the
three stress conditions. Table 2 contains the ACL means for this matrix

Table 1

Mean Adjective Check List Scores for the Three Stress Conditions

	Control n=58		Ego n=56		Shock n=53	
	Mn.	S.D.	Mn.	S.D.	Mn.	S.D.
ACL #1 (Before instructions)	6.76	8.11	6.61	6.35	5.13	5.69
ACL #2 (After instructions)	6.38	8.51	6.61	7.01	8.64	8.84
ACL #3 (End of experiment)	5.05	7.74	6.12	6.88	7.89	8.55
ACL Change, #2 minus #1	-.38		0.00		+3.51	
ACL Change, #3 minus #1	-1.71		-0.49		+2.76	

Table 2

Mean Pre- and Post-Stress Adjective Check List Scores:
Stress Condition vs. Test Anxiety Questionnaire Level

		Control			Ego			Shock		
		Mn.	n	S.D.	Mn.	n	S.D.	Mn.	n	S.D.
High Anxious	First ACL	11.37	19	11.52	11.39	18	7.13	7.25	16	7.85
	Second ACL	12.16	19	12.00	10.83	18	6.73	13.13	16	10.69
	ACL Change	+0.79			-0.56			+5.88		
Middle Anxious	First ACL	5.32	19	4.64	6.11	19	5.12	4.78	18	5.02
	Second ACL	3.63	19	3.15	7.00	19	7.93	7.83	18	8.12
	ACL Change	-1.69			+0.89			+3.05		
Low Anxious	First ACL	3.75	20	4.88	2.58	19	3.32	3.68	19	3.73
	Second ACL	3.50	20	5.07	2.21	19	2.88	5.63	19	6.66
	ACL Change	-0.25			-0.37			+1.95		

and Table 3 summarizes the analysis of covariance[15].

The second ACL measure, which was taken immediately after the stress
instructions were given, is a result both of the initial arousal level
and the effect of the experimental manipulation. Before the contribution
of initial level is removed by covariance, a significant F is not obtained
for Stress; this is apparently a result of the fact that the Shock subjects,
by chance, started at a lower initial ACL level than the Control and Ego
subjects. The TAQ term for the unadjusted measures is highly significant,
indicating a relationship between TAQ and the post-stress level of aroused
anxiety.

After covariance removes the contribution of initial ACL level from
the post-stress measure, the analysis represents the effect of the experi-
mental variables on the degree of change in ACL level. As Table 3 indi-
cates, the Stress condition variable relates to the extent of ACL change
at the .001 significance level. Examination of the change scores, in
Table 2, in conjunction with the t-tests reported earlier, supports the
view that the source of this effect is the fact that the Shock stress
condition increased anxiety while the other conditions did not. The
effect of TAQ only approaches significance, with high TAQ subjects tend-
ing to increase somewhat more in anxiety.

In summary, the covariance and t-test analyses of ACL measures to-
gether indicate that Shock stress increased reported anxiety, that Ego
stress at best only served to maintain the initial level of anxiety, and
that the Control, low stress, manipulation gradually reduced anxiety.
The stressors, then, functioned as intended for the Control and Shock

15. Because of slightly differing numbers of subjects in the cells, the
sum, variance, and covariance of each cell were adjusted in propor-
tion to the number of subjects in that cell. (See Ferguson, 1959.)

Table 3

Analysis of Covariance

Post-Stress Check List Scores with Pre-Stress Level Covaried

Source		Before Adjustment				After Adjustment		
	df	Mean Square	F	p	df	Mean Square	F	p
Stress	2	99.69	1.72	N.S.	2	247.00	9.55	.001
TAQ Level	2	1,006.16	17.35	.001	2	67.64	2.62	.10
Stress X TAQ	4	36.00	<1	N.S.	4	34.09	1.32	N.S.
Error	158	53.00			157	25.86		

groups, but had little effect on the anxiety level of subjects in the Ego Stress condition.

The other direct measure of anxiety-associated arousal is the palmar perspiration measure. Table 4 presents these data for the PPM given at four different times during the course of the experimental session. The general pattern is very different from that seen for the ACL measures, with all groups showing a decrement from the initial level. By t-test for the difference between correlated means, this decrement is significant at the .05 probability level for the Shock group and at the .10 level for the other groups. The difference between the initial and the third and fourth measures is significant at beyond the .05 level for all groups.

The difference in stress effect on these two measures, ACL and PPM, both of which are purported to assess anxiety arousal, calls to attention the set of interrelationships among the several anxiety measures that were given prior to and during the experimental session. The details of these results are confined to Block (1963, Appendix D). Of greatest interest is the fact that the correlation between PPM and ACL is in general very low. (The average of these correlations is .15.) This is true in spite of the fact that the correlations between different administrations of the same measure are high enough to indicate that both measures have fairly high reliability. (In the Control condition, the first and second ACL measures correlate .94, the first and second PPM measures correlate .64.)

The correlations between the predispositional anxiety questionnaires and the ACL and PPM warrant two conclusions. (These correlations may be found in Block (1963, Appendix D.) First, there is a consistent but moderately small correlation between the questionnaires designed to measure the predisposition to anxiety arousal and the ACL index of arousal. The correlations average around .40. There is clearly little relationship, however,

Table 4

Mean Palmar Perspiration Measure Scores for the Three Stress Conditions

	Control n=58		Ego n=56		Shock n=53	
	Mn.	S.D.	Mn.	S.D.	Mn.	S.D.
PPM #1 (Before instructions)	14.91	12.71	17.23	14.22	15.60	14.32
PPM #2 (After instructions)	12.72	9.14	14.93	11.21	11.62	11.21
PPM #3 (After first six problems)	11.60	9.35	9.93	8.65	11.73	9.84
PPM #4 (After all 12 problems)	10.46	8.56	11.68	8.87	11.32	8.81

between the predispositional questionnaires and the PPM. The reason that these predispositional indices relate to some degree with ACL but apparently do not relate to PPM may reside simply in the fact that both the ACL and the predispositional questionnaires involve reports about consciously-perceived anxiety symptoms, while the PPM indexes a not-very-salient physiological response. It appears that if the PPM measures a component of anxiety, it is a component largely independent of the conscious anxiety feelings measured by the ACL and the predispositional questionnaires.

Of the two direct measures of arousal, the ACL alone reflects differences in the stress manipulations. The fact that these differences are in the expected direction for the Control and Shock conditions lends support to the validity of the ACL as an index of aroused anxiety. Additional support for the ACL's validity is found in the correlations with the frequently-used TAQ. In view of these facts, in combination with the generally inconclusive relationships obtaining for the PPM, it was decided to focus exclusively upon the ACL as the direct index of the degree of aroused anxiety.

The learning task means are presented in Table 5. Contrary to expectation, there were no meaningful differences among the stress conditions in learning performance. Also, in contrast to the findings of Spence, Farber, and McFann (1956) for a similar learning task, there was no pattern of positive relationship between learning performance and any of the anxiety indices. With the TAQ, the highest correlation is -.13; the average correlation of the two learning indices over the pre- and post-stress trials is -.03.

Since the expected positive relationships with stress and anxiety did not occur, the learning measure could not be used as an index of drive arousal as had been hoped. Although of some interest in itself, this

Table 5

Mean Pre- and Post-Stress Learning Scores

	Control n=58		Ego n=56		Shock n=53	
	Mn.	S.D.	Mn.	S.D.	Mn.	S.D.
Number of Errors						
Before Stress Instructions	21.93	10.20	20.09	11.27	20.92	11.05
After Stress Instructions	17.03	8.36	15.63	9.20	17.00	8.98
Pre-Stress Minus Post-Stress	4.90		4.46		3.92	
Number of Trials to Two Successive Perfect Trials						
Before Stress Instructions	6.07	1.78	5.77	1.94	5.81	1.66
After Stress Instructions	5.45	1.69	5.34	1.92	5.51	1.83
Pre-Stress Minus Post-Stress	.62		.43		.30	

performance measure will not be further analyzed in this paper.

The major conclusions arising from the preceding analysis of the three arousal indices are as follows: first, the ACL is to be focused upon as the primary index of anxiety arousal; second, the ACL scores indicate effective anxiety arousal in the Shock stress condition and anxiety reduction in the Control condition; third, the ACL scores indicate that the Ego-threat manipulation was ineffective.

Since this indication of the ineffectiveness of the Ego stress is not contravened by any evidence from the PPM or the learning task, it was decided to omit the Ego condition from the analyses of problem solving scores which will follow[16].

Performance on Problem Solving

The focal point of the study is the relationship of the stress and anxiety variables to problem solving performance. The mean scores on problem solving are presented in Table 6 for the Control and Shock conditions and the three TAQ levels. An analysis of covariance on this 2X3 matrix of problem solving scores, with Administrative and Electronics Aptitude controlled through multiple-regression covariance, is summarized in Table 7[17].

With aptitude controlled by covariance, the anxiety effect is significant at the .05 level and the stress effect reaches the .12 probability level.

The problem solving means adjusted by the covariance with aptitude

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16. The mean problem solving scores for the Ego condition are presented in Block (1963, Appendix I).
17. Because of slightly differing number of subjects among the cells, a correction for unequal n's was made in the analysis. (See footnote 15, p. 31.)

Table 6

Mean Problem Solving Scores:

Stress Condition vs. Test Anxiety Questionnaire Level

	Control			Shock			Total		
	Mn.	n	S.D.	Mn.	n	S.D.	Mn.	n	S.D.
High Anxious	5.66	19	1.39	5.34	16	1.87	5.51	35	1.65
Middle Anxious	4.53	19	1.74	5.61	18	2.10	5.06	37	2.00
Low Anxious	5.63	20	2.18	6.42	19	1.76	6.01	39	2.05
Total	5.28	58	1.90	5.82	53	1.96	5.50	111	1.85

Table 7

Analysis of Covariance:

Problem Solving Scores, Stress Condition vs. Three Levels of Test Anxiety
with Administrative Aptitude and Electronics Aptitude Covaried

Source	Before Adjustment				After Adjustment			
	df	Mean Square	F	p	df	Mean Square	F	p
Stress	1	8.80	2.45	.13	1	8.17	2.55	.12
TAQ Level	2	9.16	2.55	.09	2	11.96	3.73	<.05
Stress X TAQ	2	3.57	<1	N.S.	2	2.60	<1	N.S.
Error	105	3.59			103	3.21		

appear in Table 8. Mean difference t-tests indicate that in the Shock condition the Low Anxious group tends to be superior to the combined High and Middle Anxious groups (t=1.86, p=.08) and in the Control condition, the Middle Anxious group is inferior to the other two groups combined (t=2.20, p<.05).

A further analysis involved a division of the subjects into two aptitude levels: those who scored above the median on both Administrative and Electronics Aptitude and those who scored below the median on either aptitude score [18]. Table 9 contains the mean scores on problem solving for groups divided on this basis.

Inspection of the table suggests that the stress and anxiety effects are largely confined to high aptitude subjects. The overall advantage of the Shock condition over the Control condition, for example, is .91 for the high aptitude subjects while for the low aptitude subjects there is a negligible difference of .09 in the opposite direction. Within the Shock condition, the superiority of Low TAQ subjects seems marked for high aptitude subjects, while there appears to be little relation with TAQ level for low aptitude subjects. Within the Control condition, there is suggestion

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18. A relationship between the size of the stress effects and aptitude level had been considered possible from the beginning of the experiment. (Prof. D. W. Taylor had predicted a higher probability of facilitation for high aptitude subjects on the assumption that they would have a higher confidence level.) However, the decision to conduct this analysis was an a posteriori decision. An original analysis of covariance which had included the Ego condition produced evidence for significant non-homogeneity of regression, severely limiting the usefulness of the covariance adjustment and suggesting that there might be significant relationships at some levels of aptitude but not at others. An aptitude-level breakdown then revealed that the primary locus of the effects was among the high aptitude subjects. This finding was of sufficient importance to warrant reporting such an analysis even after the decision to exclude the Ego group from the analysis unexpectedly removed the heterogeneity of regression. The fact that the effect had been informally predicted further supported the decision to report this analysis.

Table 8

Problem Solving Means Adjusted by Covariance

on Administrative Aptitude and Electronics Aptitude:

Stress Condition vs. Test Anxiety Questionnaire Level

	Control	Shock	Total
High Anxious	5.50	5.48	5.49
Middle Anxious	4.47	5.50	4.97
Low Anxious	5.61	6.44	6.01
Total	5.20	5.83	5.50

Table 9

Mean Problem Solving Scores:

Stress Condition vs. Test Anxiety Questionnaire Level
for Two Levels of Aptitude

High Aptitude

	Control			Shock			Total		
	Mn.	n	S.D.	Mn.	n	S.D.	Mn.	n	S.D.
High Anxious	6.10	10	1.31	6.19	8	2.46	6.14	18	1.78
Middle Anxious	4.79	14	1.97	6.00	13	2.21	5.37	27	2.10
Low Anxious	6.41	11	1.69	7.46	12	1.19	6.96	23	1.49
Total	5.67	35	1.79	6.58	33	1.97	6.11	68	1.90

Low Aptitude

	Control			Shock			Total		
	Mn.	n	S.D.	Mn.	n	S.D.	Mn.	n	S.D.
High Anxious	5.17	9	1.45	4.50	8	1.11	4.85	17	1.27
Middle Anxious	3.80	5	1.50	4.60	5	1.74	4.20	10	1.52
Low Anxious	4.67	9	2.76	4.64	7	1.35	4.66	16	2.12
Total	4.68	23	1.98	4.57	20	1.21	4.63	43	1.63

of a curvilinear relationship with TAQ level for both aptitude groups, but this, too, is more marked in the high aptitude sub-group.

An analysis of covariance (unweighted means) for the high aptitude group is summarized in Table 10[19]. For these high aptitude subjects, a significant TAQ effect is again obtained (p=.02), as it was for the analysis over all subjects that was reported in Table 8; in addition, however, the stress effect attains a significant level (p<.05)[20].

The high aptitude means adjusted for covariance appear in Table 11. It is clear that the significant overall stress effect is caused by the advantage of the Shock condition for middle- and low-anxious subjects; for high anxious subjects, the stress condition appears to make little difference. Mean difference t-tests indicate that the Middle Anxious Shock group is superior to its Control counterpart at beyond the .05 level (t=2.26), while the advantage of the Shock condition for the Low Anxious subjects reaches the .08 level (t=1.81).

Within the Shock condition, the Low Anxious subgroup is superior to both the Middle Anxious and High Anxious subgroups at beyond the .05 level (t=2.09 and 2.00 for the differences with Middle and High Anxious, respectively). Within the Control condition, the Middle Anxious group is inferior to the other two groups, at the .05 level with respect to the Low Anxious group (t=2.36) and at the .10 level with respect to the High Anxious group (t=1.72).

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19. Only Administrative Aptitude is used as the covariate in this analysis, since only with this aptitude measure does a correlation with aptitude remain after the subjects have been partitioned by aptitude level.
20. Similar results are obtained by an analysis of variance for the high aptitude group, using the least-squares method of correcting for unequal numbers of subjects. An F of 4.85 for the Stress term reaches the .05 significance level, while an F of 4.08 for the Anxiety term reaches the .025 level. Again, the interaction term is not significant.

Table 10

Analysis of Covariance: High Aptitude Subjects

Problem Solving Scores, Stress Condition vs. Three Levels of Test Anxiety
with Administrative Aptitude Covaried

Source	Before Adjustment				After Adjustment			
	df	Mean Square	F	p	df	Mean Square	F	p
Stress	1	10.08	3.26	.10	1	14.86	5.04	.05
TAQ Level	2	12.99	4.20	.025	2	13.18	4.47	.02
Stress X TAQ	2	2.03	<1	N.S.	2	2.89	<1	N.S.
Error	62	3.09			61	2.95		

Table 11

Problem Solving Means Adjusted by Covariance

on Administrative Aptitude: High Aptitude Subjects,

Stress Condition vs. Test Anxiety Questionnaire Level

	Control	Shock	Total
High Anxious	5.94	6.09	6.01
Middle Anxious	4.72	6.21	5.44
Low Anxious	6.35	7.65	7.03
Total	5.58	6.70	6.13

Duncan tests, which are designed for a posteriori testing of mean differences and so are more conservative, tend to support the conclusions based on t-tests, although fewer of the differences attain the .05 level. By Duncan test, the Shock advantage over Control does not quite reach the .05 level for either Middle or Low Anxious subjects. Within the Shock condition, the Low Anxious subjects are superior to the High Anxious subjects at the .05 level but their advantage over the Middle Anxious group does not reach the .05 level. Within Control, the Middle Anxious - Low Anxious difference reaches significance but the Middle Anxious - High Anxious difference does not.

In summary, the analysis of problem solving scores for all subjects demonstrates a significant relationship between TAQ level and problem solving. When the analysis is limited to subjects of high aptitude, the data tend to support the view that there is also a significant stress effect, with the Shock stress condition superior. Within the Shock condition, the Low TAQ group appears to be superior to the two higher TAQ groups, while in the Control condition the Middle Anxious group tends to be inferior to the two extreme TAQ groups.

Reliability of the Problem Solving Measure

The reliability of the set of problems was estimated at .56. Reliability was estimated by applying the Spearman-Brown formula to the correlation, within the Control group, of two six-item subsets created by pairing items on difficulty level. Since the original order of the problems was determined in part by varying the difficulty level of successive problems, the subsets used in the reliability estimation approximated those of an alternate-items reliability estimation.

It was suggested that a subset of the problems might have almost equally high reliability and be more responsive to the experimental variables. Accordingly, a supplementary analysis was executed. It was begun by correlating each problem with the total problem solving score. Then, those six problems which correlated most highly with the overall score (all correlated at .41 or above) were combined into a new scale. The reliability of this six-item scale, computed in the same manner as for the twelve-item scale, was .54, nearly as high as for the twelve-item scale, although half its length.

Problem solving scores were obtained for all subjects on the basis of this new scale, and breakdowns on stress, anxiety, and aptitude level parallel to those reported above were executed. The results of these analyses indicated a pattern of relationships very similar to those based on the twelve-item scale. It appeared that in no instance would a relationship not previously significant now reach a significant level. Accordingly, this analysis was not carried further.

Anxiety Arousal Mechanisms

The next question to be examined is whether the TAQ and stress relationships with problem solving can be accounted for by the level of anxiety arousal, as indexed by the ACL. The ACL means appropriate to the analysis have been reported earlier, in Tables 1 and 2. The appropriate problem solving means are in Tables 8 and 9.

It is clear that a simple, linear relationship relating ACL level to the performance measures is not tenable, since superior problem solving is associated with a significant increase in ACL-indexed anxiety when Control

and Shock stress conditions are compared, but is _inversely_ associated with the degree of ACL increase, (and with initial and post-stress levels), when TAQ levels within the Shock condition are compared.

One resolution of this apparent contradiction is to assume a curvilinear relationship between ACL change and problem solving, such that a moderate degree of ACL change would be associated with maximal problem solving performance. Thus, the Low TAQ Shock subgroup's increase of 1.95 from the first to the second ACL would be near the maximally effective level; this subgroup had the highest problem solving score. The four subgroups which clustered together on problem solving all showed either little change or a considerable increase, while the subgroup lowest on problem solving, Middle TAQ Control, was the only one to show a significant decline in ACL level (this group's decline of 1.69 is significant at the .02 level, t=2.67).

Somewhat contravening the probability that such a relationship is valid are the correlations _within_ the subgroups between problem solving and ACL change [21]. Among the expectations arising from the curvilinear hypothesis would be the following, with the relationships that were actually observed listed in parentheses: a _positive_ relationship in the three Control subgroups, particularly in the Middle TAQ group (Observed: Middle Anxious, -.54; Low Anxious, -.14; High Anxious, -.28); a negative relationship in

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21. These have been estimated by Quennoille's formula for the correlation of one variable with the difference between two other variables:

$$r_{P.S.(ACL_2-ACL_1)} = \frac{r_{P.S.(ACL_2)} - r_{P.S.(ACL_1)}}{2(1-r_{ACL_2 \cdot ACL_1})}$$

the Middle and High Anxious Shock subgroups (Observed: Middle Anxious, +.07; High Anxious, -.33). Only one of the five expected relationships is even in the correct direction. Although there are definite limitations on the validity of these correlations arising from the limited reliability of the problem solving scale, the relatively small numbers of subjects in each cell, and the restricted ranges on ACL, the overall lack of congruence with the patterns demanded by a curvilinear relationship remains impressive. Of particular interest is the appreciable negative correlation (r=-.54) in the Middle TAQ group, which was at the low end of both the ACL change and the problem solving distributions.

There is thus serious question as to whether anxiety arousal, per se, as measured by the ACL, played a major role in mediating the observed stress and TAQ effects on problem solving.

Correlations

Block (1963, Appendix E) reports the correlations, with problem solving, of all the indices of anxiety and attitude that were used, with groups classified on the basis of aptitude level and stress condition.

The correlations with problem solving tend to be low and non-significant. Because of the limited reliability of the problem solving battery, the implications of this and the more specific findings are not clear; they are, however, suggestive.

Perhaps of greatest interest is the fact that although the various predispositional anxiety measures tend to be highly correlated among themselves, their correlations with problem solving tend to be rather different and to be dependent on the stress condition and aptitude levels

of the subjects. Thus, for high aptitude subjects, the only predisposi-
tional measures which approach a significant level of correlation with
problem solving are as follows: for Control, the Anxiety Arousal Scale;
for Ego Stress, the Body Anxiety Scale and the debilitative subtest of
the Achievement Anxiety Scale; and, for Shock Stress, the TAQ. For low
aptitude subjects, still different scales tend to be the superior cor-
relates of problem solving performance, with the facilitative and debili-
tative subtests of the Anxiety Response Scale and the Anxiety Arousal
Scale being those which are most consistently high. Although these re-
lationships are of interest, their importance is qualified by the limited
reliability of the problem solving scale. In view of this limitation, and
the fact that these relationships are somewhat peripheral to the primary
results of the study, they will not be further analyzed in the present
report.

DISCUSSION

Effectiveness of Stress Manipulations

The measures of anxiety arousal taken during the session indicated that the instructions were successful in increasing anxiety in the Shock-threat condition and in reducing anxiety in the Control, low-threat, condition. Comparisons between these two conditions are thus of interest. Since the Ego-threat manipulations did not increase anxiety, the expected comparison between stresses low and high in ego-threat cannot be made.

There are several possible reasons for the ineffectiveness of the Ego-threatening instructions. First, the experimenter and the experimental situation might not have been perceived as very central to the subjects' real-life system of rewards and punishments. Second, it was learned that the Air Force subjects used in this experiment had become quite accustomed to public announcement of their relative standings on tests; the threat of such announcements was one of the central ego-stress manipulations. Finally, these subjects represented a population that was probably selected, in part, on the basis of ability to tolerate ego-threat.

The fact that there is definite evidence for the failure of the ego-stress manipulations to arouse anxiety is of some interest in itself, for it emphasizes the great importance of using measures of transient anxiety arousal. It is significant that such measures of arousal have rarely been used in studies of the effects of anxiety and stress on performance. Since the kinds of stress manipulations in the Ego-threat condition were in most respects similar to those used in other experiments, it seems very likely

that the criterion of threat-related anxiety arousal has, unknowingly, not been met in some previously reported experiments. It is even entirely possible that many experimental threat situations which have produced effects on performance (learning achievement, for example) have not affected the level of aroused anxiety. Further use of such repeatable indices of transient arousal level as the ACL and physiological indices might be very helpful in clarifying some of the contradictory results that have been reported.

Although the ACL proved an effective indicator of anxiety arousal, the PPM did not. There is no evidence to indicate why the PPM did not reflect differences between the stress conditions; however, one distinct possibility is that the PPM is related primarily to that type of anxiety arising from feelings of ego-threat. Such stress situations as psychotherapy (Mowrer, 1953), Ph. D. oral examinations (Bixenstein, 1955) and performing before an audience (Paivio and Lambert, 1959) are clearly related to the ego-threatening aspects of anxiety; it is in such situations that the clearest evidence for the validity of the PPM has been forthcoming. The fact that the Shock stress condition did not produce an increase in PPM level would then be consistent with the design of this stress manipulation, which included a reduction in ego-threat cues.

An alternative possibility is that only at higher levels of anxiety than those extant here is the PPM index responsive to changes in anxiety level.

It is also not possible to know for certain why the learning tasks were not sensitive to differences in anxiety level and stress conditions. A probable explanation centers about the fact that the subjects who were

used had had, as a result of their activities in learning Chinese, a large amount of training in rote learning. One result of such extensive training would likely be to make the individual mode of response to a rote learning task less dependent on individual personality characteristics or emotional states, and more dependent on reasonably adaptive habits. It may be important that for most subject populations which have been used in previous studies, the timed rote-learning procedure is quite a new experience; this newness may be a major source of both the anxiety and the potential for emotional disruption and facilitation.

Relationships with Problem Solving

The problem solving differences observed between the Shock and Control conditions, and those related to TAQ level, are of interest, in spite of the fact that the comparison with Ego-threatening stress conditions cannot be made.

The inability to compare the results of Shock and Ego stress does, however, limit the usefulness of any extensive discussion of the initial theoretical model and hypotheses. In brief, those expectations that remain relevant are as follows: (a), Shock stress will facilitate performance in comparison with Control; (b), TAQ level will be positively related to facilitation in Shock stress; (c), (an alternative to the previous hypothesis), TAQ level will be curvilinearly related to performance in Shock stress; (d), measures of aroused anxiety will be related to any problem solving differences noted among the stress and anxiety subgroups. Of these four hypotheses, the evidence supports only the first. The evidence relevant to the second and third is clearly negative, and while the

evidence for the fourth is ambiguous, it tends to be negative, at least so far as the ACL index is concerned.

The evidence is consonant with that aspect of the original model concerned with the facilitative effects of stress when the stress is low in ego-threatening cues. It is of considerable interest that high anxious subjects (as determined by TAQ scores) were not debilitated by the Shock-stress condition, even though a significant increase in anxiety was produced in these subjects. This contrasts with the very common finding that stresses high in ego-threat produce disruption for anxious subjects. Thus, in spite of the failure of the ego-stress manipulation, there is some support for the assumption that a stress low in ego-threat cues will have less of a tendency to disrupt performance than a stress which is high in such cues.

The evidence is quite clear, however, that the facilitation is not mediated, in a simple multiplicative fashion, by the degree of anxiety that is aroused. The aspects of the model leading to this expectation are not supported. In consequence, each of the major findings will be briefly discussed in terms of a simpler model, one in which "level of self-confidence" is the central concept.

An initial question is why the anxiety and stress effects were centered primarily among high aptitude subjects. We would propose that level of self-confidence is a critical mediator of the facilitative effects of stress: only subjects who feel confident that by an increase in effort they can in fact improve performance enough to avoid the painful consequences of poor performance will be likely to direct their motivation to such an increase in effort, and thus only confident subjects will show

improved performance. Subjects high in intellectual aptitude would much more likely have had a background of reinforcing experiences that would contribute to having a high confidence level in an intellectual task stress situation, and would therefore more likely respond to the Shock-threat conditions by increasing effort.

The concept of self-confidence also serves to explain the fact that the improvement due to Shock stress was confined to subjects in the lower and middle levels of test anxiety, for the confidence level of such subjects would be reasonably high, while the confidence level of subjects who rate themselves as chronically anxious in test situations would likely be low.

The relationship with TAQ level within the Shock condition would be congruent with the confidence level explanation, for it would depend only on the preceding assumption of an inverse relationship between confidence level and TAQ level. However, this type of explanation does not appear applicable to the TAQ relationships found within the Control condition, for in this condition the subjects had no grounds for expecting to avoid a punishment or obtain a reward for superior performance. The observed curvilinear relationship with TAQ level would therefore have to be explained on different grounds.

A curvilinear relationship in which the middle anxious subjects are inferior is an unusual one in anxiety-performance relationships; the only major study reporting such a relationship is that by Travers, et al., who found it to hold in only one of two replications. The most striking characteristic of the Middle TAQ group in this experiment is its significant decline in aroused anxiety after hearing the stress-reducing instructions.

This is the only subgroup to show such a decline. One interpretation for the fact that only the Middle TAQ subjects decline in anxiety would be to assume that chronically high-anxious people tend to be relatively unresponsive to threat-reducing cues, and that low-anxious people have little anxiety to be reduced. The middle-anxious subjects, then, would tend to be the only ones responsive to reductions in the stress stimuli.

The proposed interpretation for the poor problem solving observed in this group is that the decline in ACL level was a result of a decline in interest in the task, resulting from the threat-reducing instructions given to the Control group. Such a reduction in interest level, in a situation where there were no external demands for good performance, would tend to produce poor performance on the subsequent problem solving task.

The foregoing set of interpretations have implicit in them the suggestion that anxiety, per se, is not an important determinant of performance when the stress is performance-facilitative. The indices of anxiety are assumed to be measuring other characteristics, the TAQ measuring confidence level and the ACL measuring task-related interest level.

While the evidence for irrelevance of aroused anxiety level to the stress and TAQ-related differences in problem solving is not conclusive, it is clear that facilitation of problem solving performance by stress is not dependent upon the production of a high level of anxiety. The subgroup most highly facilitated on problem solving, Low TAQ Shock, was in fact the group showing the smallest increase, and the lowest post-

stress level, of ACL-indexed anxiety [22].

In relation to the facilitation by stress, observed among high aptitude subjects, it should be noted that this finding is consistent with the findings of Cattell and Scheier (1958, 1960), who report that the anticipation of a realistic threatening situation (running to exhaustion on a treadmill) markedly _decreased_ the level of the anxiety-related factor they have labelled "Neurotic Debility." They suggest that "challenge to effort, with minimal involvement of major sentiment systems and their attendant anxieties . . . stimulates the capacity to mobilize . . . ." The Shock stress situation used in the present experiment was designed to have just these characteristics. They have further found that the "Neurotic Debility" factor is related to performance on a wide variety of cognitive tasks, while the factor they label "Anxiety" does not relate to such performance. It is only necessary to equate "lack of confidence," which we assumed TAQ to index, with "neurotic debility," to make this finding consistent with the fact that in this experiment TAQ was related to performance, but the relationship was apparently not mediated by aroused anxiety level.

Similarly consistent is Van Buskirk's (1961) recent finding, referred to earlier, that fear-of-failure is negatively related to performance on

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22. A decision as to how general this finding is would require further investigation using as large a number of different indices of aroused anxiety as possible; it is quite possible that other indices would reflect a mediating role even though the indices used here did not. The correlation among indices purporting to measure anxiety is notoriously low, as has been demonstrated by Lacey (1956) and by Mandler, Mandler, Kremen and Sholiton (1961).

complex reasoning tasks while anxiety-related Drive, as measured by the
Manifest Anxiety Scale, is positively related to performance. These
studies strongly urge the usefulness of further attempts at discriminating
between the activation component of anxiety and other components.

Interaction of Task Characteristics with Stress and Anxiety Factors

The discussion up to this point has spoken of stress-related facili-
tation and disruption as general effects. Yet it is highly probable that
tasks vary in their sensitivity to both disruption and facilitation.
Since only one type of task was analyzed in the present experiment, it
is impossible to know to what extent the observed relationships with per-
formance depended on the special characteristics of the problem solving
task. We can, however, suggest some probable effects of task differences.

A notable difference between the type of problem solving task used
here and the typical rote learning task is in the length of the time
interval allowed for responding. The much longer period for response in
the problem solving task would in all likelihood make it less sensitive
to disruption through blocking by momentarily-competing responses and
through momentary lapses and shifts of attention. It is momentary ef-
fects which may be produced by the Drive, or arousal, components of an
anxiety response. The lack of any evidence of disruption within the
Shock condition could, then, be explained by assuming that the anxiety
arousal produced by the Shock-stress condition would not be likely to
have a disruptive effect on this task, although it might on tasks with
other characteristics.

There is, then, question as to how much the facilitative effects of stress in the present study depended on the task, and to what extent they are generalizable to other kinds of performance. This can of course only be answered through future experimentation, in which both task and stress characteristics are varied and where a separation is made among the several probable components of the anxiety response.

REFERENCES

Alpert, R., & Haber, R. N. Anxiety in academic achievement situations. J. abnorm. soc. Psychol., 1960, 61, 207-215.

Beam, J. C. Serial learning and conditioning under real-life stress. J. abnorm. soc. Psychol., 1955, 51, 543-551.

Beier, E. G. The effects of induced anxiety on flexibility of intellectual functioning. Psychol. Monogr., 1951, 65, No. 9 (Whole No. 326).

Berry, P. C. An exploration of the interrelations among some non-intellectual predictors of achievement in problem solving. Unpublished doctoral dissertation, Yale University, 1959.

Bixenstein, V. E. A case study of the use of palmar sweating as a measure of psychological tension. J. abnorm. soc. Psychol., 1955, 50, 138-143.

Blatt, S. J. Patterns of cardiac arousal during complex mental activity. J. abnorm. soc. Psychol., 1961, 63, 272-282.

Block, C. H. An attempt to produce attitude change and concomitant performance change in problem solving. Unpublished manuscript, Yale University, 1959.

Block, C. H. Interrelations of stress and anxiety in determining problem solving performance. Unpublished doctoral dissertation, Yale University, 1963.

Calvin, A. D., Koons, P. B., Jr., Bingham, J. L., & Fink, H. H. A further investigation of the relationship between manifest anxiety and intelligence. J. consult. Psychol., 1955, 19, 280-282.

Carey, Gloria L. Reduction of sex differences in problem solving by improvement of attitude through group discussion. Stanford: Dept. Psychol. Stanford Univ. (Tech. Rpt. No. 9, contract N6onr 25125). A condensed form of this report appears as: Carey, Gloria L., Sex differences in problem solving as a function of attitude differences. J. abnorm. soc. Psychol., 1958, 56, 256-260.

Cattell, R. B., & Scheier, I. H. The nature of anxiety: a review of 13 multivariate analyses comprising 814 variables. Psychol. Rep., 1958, 4, 351-358.

Cattell, R. B., & Scheier, I. H. Stimuli related to stress, neuroticism, excitation, and anxiety response patterns: illustrating a new multivariate experimental design. J. abnorm. soc. Psychol., 1960, 60, 195-204.

Child, I. L. Personality. Annu. Rev. Psychol., 1954, 5, 149-170.

Chiles, W. D. Effects of shock-induced stress on verbal performance. J. exp. Psychol., 1958, 56, 159-165.

Deese, J., Lazarus, R. S., & Keenan, J. Anxiety, anxiety reduction, and stress in learning. J. exp. Psychol., 1953, 46, 55-60.

Duncan, D. B. Multiple range and multiple F tests. Biometrics, 1955, 11, 1-42.

Farber, I. E., & Spence, K. W. Complex learning and conditioning as a function of anxiety. J. exp. Psychol., 1953, 45, 120-125.

Ferguson, G. A. Statistical analysis in psychology and education. New York: McGraw-Hill, 1959.

Graff, N. The relationship of manifest anxiety, ways of handling anxiety, task difficulty, and task evaluation to performance on an intellectual task. Dissertation Abstr., 1957, 17, 1584-1585. (Abstract)

Grice, G. R. Discrimination reaction time as a (f) of anxiety and intelligence. J. abnorm. soc. Psychol., 1955, 50, 71-74.

Guilford, J. P. The structure of intellect. Psychol. Bull., 1956, 53, 267-293.

Haagen, C. H. Synonymity, vividness, familiarity, and association value ratings of 400 pairs of common adjectives. J. Psychol., 1949, 27, 453-463.

Kanfer, F. H. Supplementary report: stability of a verbal rate change in experimental anxiety. J. exp. Psychol., 1958, 56, 182-184.

Katchmar, L. T., Ross, S., & Andrews, T. G. Effects of stress and anxiety on performance of a complex verbal coding task. J. exp. Psychol., 1958, 55, 559-564.

Kerrick, Jean S. Some correlates of the Taylor Manifest Anxiety Scale. J. abnorm. soc. Psychol., 1955, 50, 75-77.

Korchin, S. J. The experimental study of anxiety. Paper delivered at the Copenhagen Symposium on Motivation and Emotion, March, 1961.

Kuno, Y. The physiology of human perspiration. London: J. & A. Churchill, 1934.

Lacey, J. I. The evaluation of autonomic responses: toward a general solution. Ann. NY Acad. Sci., 1956, 67, 123-164.

Lucas, J. D. The interactive effects of anxiety, failure, and intraserial duplication. Amer. J. Psychol., 1952, 65, 59-66.

McGuigan, F. J., Calvin, A. D., & Richardson, Elizabeth C. Manifest
anxiety, palmar perspiration-index, and stylus maze-learning.
Amer. J. Psychol., 1959, 72, 434-438.

Malmo, R. B. Measurement of drive: an unsolved problem in psychology.
In M. R. Jones (Ed.), Nebraska Symposium on Motivation. Lincoln:
Univ. of Nebraska Press, 1958. Pp. 229-265.

Maltzman, I., Fox, J., & Morrisett, L., Jr. Some effects of manifest
anxiety on mental set. J. exp. Psychol., 1953, 46, 50-54.

Mandler, G., Mandler, Jean M., Kremen, I., & Sholiton, R. D. The response
to threat: relations among verbal and physiological indices. Psychol.
Monogr., 1961, 75, No. 9 (Whole No. 513).

Mandler, G., & Sarason, S. B. A study of anxiety and learning. J. abnorm.
soc. Psychol., 1952, 47, 166-173.

Milton, G. A. The effects of sex role identification upon problem solving
skill. J. abnorm. soc. Psychol., 1957, 55, 219-244.

Mowrer, O. H. Psychotherapy theory and research. New York: The Ronald
Press Co., 1953.

Nakamura, C. Y. The relation between conformity and problem solving.
Stanford: Dept. Psychol Stanford Univ., (Tech. Rpt. No. 11, contract
N6onr 25125), 1955. A condensed form of this report appears as:
Nakamura, C. Y. Conformity and problem solving. J. abnorm. soc.
Psychol., 1958, 56, 315-320.

Nicholson, W. M. The influence of anxiety upon learning: interference
or drive increment? J. Pers., 1958, 26, 303-319.

Nowlis, V. Some studies of the influence of films on mood and attitude.
Rochester: Dept. Psychol. Univ. of Rochester, (Tech. Rpt. No. 7,
Research Program on Mood and Attitude Change, contract Nonr-668-12),
1960.

Paivio, A., & Lambert, W. E. Measures and correlates of audience anxiety
("stage fright"). J. Pers., 1959, 27, 1-17.

Ray, W. S. Repetition of two experiments on mild stress and problem
solving. Bethany, W. Va.: Bethany College, Cognitive Operations
Laboratory (Tech. Rpt. No. 4, contract Nonr-2315-00), 1960.

Reynolds, G. S. The effects of stress upon problem solving. J. gen.
Psychol., 1960, 62, 83-88.

Rhine, R. J. The effect on problem solving of success or failure as a
function of cue specificity. Stanford: Dept. Psychol. Stanford
Univ., (Tech. Rpt. No. 8, contract N6onr 25125), 1955.

Ruebush, B. K. Interfering and facilitating effects of test anxiety. J. abnorm. soc. Psychol., 1960, 60, 205-212.

Sarason, I. Effect of anxiety, motivational instructions, and failure on serial learning. J. exp. Psychol., 1956, 51, 253-260. (a)

Sarason, I. The relationship of anxiety and "lack of defensiveness" to intellectual performance. J. consult. Psychol., 1956, 20, 220-222. (b)

Sarason, I. The effects of anxiety and two kinds of failure on serial learning. J. Pers., 1957, 25, 383-392.

Sarason, I. Effects on verbal learning of anxiety, reassurance, and meaningfulness of material. J. exp. Psychol., 1958, 56, 472-477.

Sarason, I. Empirical findings and theoretical problems in the use of anxiety scales. Psychol. Bull., 1960, 57, 403-415.

Sarason, I. The effects of anxiety and threat on the solution of a difficult task. J. abnorm. soc. Psychol., 1961, 62, 165-168.

Sarason, S. B., Davidson, K. S., Lighthall, F. F., Waite, R. R., & Ruebush, B. K. Anxiety in elementary school children. New York: John Wiley and Sons, 1960.

Sarason, S. B., & Mandler, G. Some correlates of test anxiety. J. abnorm. soc. Psychol., 1952, 47, 810-817.

Silverman, J. J., & Powell, V. E. Studies on palmar sweating, I and II. Amer. J. Med. Sci., 1944, 208, 297-299, 299-305.

Silverman, J. J., & Powell, V. E. Studies on palmar sweating. Psychosom. Med., 1944, 6, 243-249.

Silverman, R. E., & Blitz, B. Learning and two kinds of anxiety. J. abnorm. soc. Psychol., 1956, 52, 301-303.

Spence, K. W., & Farber, I. E. Conditioning and extinction as a function of anxiety. J. exp. Psychol., 1953, 45, 116-119.

Spence, K. W., Farber, I. E., & McFann, H. H. The relation of anxiety (drive) level to performance in competitional and non-competitional paired-associates learning. J. exp. Psychol., 1956, 52, 296-305.

Spence, K. W., Farber, I. E., & Taylor, Elaine. The relation of electric shock and anxiety to level of performance in eyelid conditioning. J. exp. Psychol., 1954, 48, 404-408.

Spence, K. W., Taylor, John, & Ketchel, Rhoda. Anxiety (drive) level and degree of competition in paired-associates learning. J. exp. Psychol., 1956, 52, 306-310.

Staats, A. W. Verbal and instrumental response-hierarchies and their relationship to problem-solving. Amer. J. Psychol., 1957, 70, 442-446.

Taylor, Janet A. A personality scale of manifest anxiety. J. abnorm. soc. Psychol., 1953, 48, 285-290.

Taylor, Janet A. Drive theory and manifest anxiety. Psychol. Bull., 1956, 53, 303-320.

Taylor, Janet A., & Spence, K. W. The relationship of anxiety level to performance in serial learning. J. exp. Psychol., 1952, 44, 61-64.

Thurstone, T. G., & Jeffrey, T. E. Concealed figures test. Copyright 1956. Distributed by Education Industry Service, Univ. of Chicago.

Travers, R. M. W., Marron, J. E., & Post, A. J. Some conditions affecting quality, consistency, and predictability of performance in solving complex problems. San Antonio: Air Force Personnel and Training Research Center, Lackland AFB, (Research Rpt. No. 27), 1955.

Truax, C. B., & Martin, B. The immediate and delayed effect of failure as a function of task complexity and personalization of failure. J. abnorm. soc. Psychol., 1957, 55, 16-20.

Van Buskirk, C. Performance on complex reasoning tasks as a function of anxiety. J. abnorm. soc. Psychol., 1961, 62, 201-209.

Waite, R. R. Test performance as a function of anxiety and type of task. Unpublished doctoral dissertation, Yale Univ., 1959.

Waite, R. R., Sarason, S. B., Lighthall, F. F., & Davidson, K. S. A study of anxiety and learning in children. J. abnorm. soc. Psychol., 1958, 57, 267-270.

Wenger, M. A., & Gilchrist, J. C. A comparison of two indices of palmar sweating. J. exp. Psychol., 1948, 38, 757-761.

Wiggins, J. G. Multiple solution anagram solving as an index of anxiety. J. clin. Psychol., 1957, 13, 391-393.

Zuckerman, M. The development of an affect adjective check list for the measurement of anxiety. J. consult. Psychol., 1960, 24, 457-462.